The Future of Computer Graphics: An Enabling Technology?

David S. Ebert*
Purdue University
Panelist & Moderator

Bill Buxton†
Alias | Wavefront, Inc.
Panelist

Patricia Davies ‡
Purdue University
Panelist

Elliot K. Fishman §
Johns Hopkins Hospital
Panelist

Andrew Glassner ¶
Coyote Wind Studios
Panelist

1 Introduction

Computer graphics research and hardware has matured as a field to the point that high-quality computer graphics is becoming ubiquitous. Computer graphics shortly will be where word processing is today: everyone uses it, but there are very few people doing basic research in word processing. All of the challenges lie in the applications and use of this technology to enable advances in many fields. This panel will combine experts in computer graphics and associated technology with experts from a few applications areas to discuss the possibilities and future ways that computer graphics can advance discovery in many fields.

2 David Ebert

With the latest advances in graphics hardware and software technology, high-quality graphics will shortly be ubiquitous and good enough for many applications. The unsolved problems that still remain are to make smaller and smaller improvements to the existing state of the art or to improve the speed and cost of the solutions. The main challenges that I see are in applying these techniques to effectively convey information to users who are trying to solve problems and deal with the data deluge that they are facing. Combining techniques from vision, art, illustration, haptics, and, most importantly, perception are essential to solve these problems. My collaborations with scientists, physicians, and information analysts have shown me that graphics developments are most effective when combined with expertise from other areas to solve real problems.

2.1 David Ebert Bio

David Ebert is an associate professor at Purdue University and has been doing research in computer graphics, procedural techniques, and visualization for fourteen years. While better known in the computer graphics community for his research in simulating natural phenomena and procedural techniques (chairing several SIGGRAPH courses and co-authoring a book on this topic), his main research is in techniques for effective visualization, developing and applying techniques from volume rendering, technical illustration, and, most recently, perception to applications ranging from document analysis to astrophysics to medical diagnosis and accuracy. He has served on several ACM SIGGRAPH committees, co-chaired the IEEE Visualization papers program, and serves as Associate Editor in Chief for IEEE Transactions on Visualization and Computer Graphics.

3 Bill Buxton

Today we find ourselves in the interesting situation where, on the one hand, there is an explosion of resources (such as cards, game machines, computers, net, ...) and stagnation, or worse in the industry (such as recent year to year decrease in the size of the SIGGRAPH trade show).

We now know how to do graphics and deliver them at mass/consumer level. While we have been brilliant at addressing the technical issues, we have been far less so in answering the question, "So what?" or "Where is the value?"

Where we are right now is a space where, outside of feature films and video games, the main contact with 3D for most people is in tumbling cars, running shoes, watches, etc. on the web. All of which brings to mind the immortal words of Peggy Lee's, "Is that all there is, is that all there is?" If so, as she says, "Let's go dancing," since we may have been wasting our time in a "Field of Dreams" (if you build it they will come) type scenario.

I, for one, think that there is value. But as long as the industry and research is dominated by people whose expertise is in graphics (the technology issues), rather than value (the human, social and business issue), then it will never be realized. Finally, I would argue that this realization will only come through a significant realignment of our discipline and industry.

3.1 Bill Buxton Bio

Panelist Bill Buxton is a designer and a researcher concerned with human aspects of technology. His work reflects a particular interest in the use of technology to support creative activities such as design, film making and music. Buxton's research specialties include technologies, techniques and theories of input to computers, technology mediated human-human collaboration, and ubiquitous computing. He is Chief Scientist of Alias|Wavefront, Inc., and its parent company SGI Inc., as well as an Associate Professor in the Department of Computer Science at the University of Toronto. While "full-time" at Alias |Wavefront, Buxton continues to supervise graduate students at the university. Buxton began his career in music, having done a Bachelor of Music degree at Queen's University. He then studied and taught at the Institute of Sonology, Utrecht, Holland, for two years. After completing an M.Sc. in Computer Science on Computer Music at the University of Toronto, he joined the faculty as a lecturer. Designing and using computer-based tools for music composition and performance is what led him into the area of human-computer interaction.

4 Patricia Davies

Patricia will talk about the work of a group at Purdue University in perception-based engineering, and the integration of perceptual models of human response to stimuli into the engineering design process. Applications include the design of interiors of the next generation of automobiles; and integration of visual, tactile and audio interfaces for natural and enhanced communications.

4.1 Patricia Davies Bio

Patricia Davies received her B.Sc. in Mathematics from the University of Bristol in 1977, and her M.Sc. and Ph.D. in Sound and Vibration from the University of Southampton in 1981 and 1985,

*e-mail: ebertd@purdue.edu
†e-mail: buxton@aw.sgi.com
‡e-mail: daviesp@ecn.purdue.edu
§e-mail: efishman@jhmi.edu
¶e-mail: andrew_glassner@yahoo.com

respectively. Dr. Davies is a faculty member at the Ray W. Herrick Laboratories, part of the School of Mechanical Engineering, where she conducts research in the areas of: (1) Nonlinear System Identification, (2) Vibration Measurements, (3) Sound Quality and Perception Based Engineering, (4) Acoustical Arrays for Sound Source Visualization, and (5) Event-based Signal Processing. She has applied her research to: modeling the dynamics of the polyurethane foam used in car seats, visualizing automobile noise sources during pass-by tests, predicting reciprocating pump failure, analyzing infant and mother laughter, and modeling human response to refrigerator, HVAC, chiller and large machinery noise. She has co-authored over 80 journal and conference papers. Currently Dr. Davies is also coordinating a group of psychology and engineering professors at Purdue who research and develop models of the effects of engineered products and systems on people. The aim is to integrate these models into the engineering design process so that engineered systems can be optimized for the people who use, or are affected by, them. Engineering and Psychology professors in this Perception-based Engineering group collaborate on projects such as image quality, sound quality, effects of noise on performance and decision making, speech and gesture perception, thermal comfort and air quality, touch and feel interfaces, interface design and response to vibration.

5 Andrew Glassner

Computer graphics has always been about building and using tools. Our tools have moved from laboratory curiosities to the local computer store's shelves, and some of our dreams from yesterday are standard components on every home system today. Science and medicine, photo editing, gaming, and film production will never be the same. What happens next?

Graphics has always been limited by the available technology, because we can only display on the hardware we've got. What happens when tabletops and wallpaper, along with the rest of the world, turn into communicating input and output devices? The whole idea of computer graphics will change from an output technique to a responsive, integrated part of our human environment.

This requires a re-thinking of what graphics is about. A satellite can gather information, but a reporter creates a story. A metronome can keep the beat, but a drummer makes it swing. Synthetic images contain data, but people give them meaning. As a field, computer graphics needs to look up from the spreadsheet and move out into the world, where we can use our tools to enhance and enrich both everyday and peak human experiences.

5.1 Andrew Glassner Bio

Andrew Glassner is a writer-director, and a consultant in story structure, interactive fiction, and computer graphics. He started working in 3D computer graphics in 1978, and has carried out research at the NYIT Computer Graphics Lab, Case Western Reserve University, the IBM TJ Watson Research Lab, the Delft University of Technology, Bell Communications Research, Xerox PARC, and Microsoft Research.

6 Elliot Fishman

When a sample of physicians was asked what the greatest impacts in medicine have been over the last few decades, they did not choose antibiotics or laparoscopic surgery or stem cell research, but instead chose medical imaging with CT and MRI.

With the newest scanners providing datasets of between 1000 and 2000 slices of 512 x 512 resolution, the challenges range from processing data on the scanner to transferring the images to workstations to being able to load data sets into memory at sufficient speed to make the process interactive. The use of isotropic data sets is ideal for high resolution 3D imaging, but only if the interactivity for the postprocessing of the data is present. With the advances in image processing and the improvement in the quality of the data set, the generation of 3D CT maps has come a long way since the mid-80's and early 90's. Where in the past the key areas of visualization were related to soft tissue or bone, currently there is a revolution in imaging ranging from applications of the vascular system to organs such as the colon and airway. The ability to scan faster allows the acquisition of vascular angiographic maps, which are equal to and better quality than classic angiography, and yet costs one-third to one-quarter as much without any of the invasiveness. The ability to acquire these data sets is revolutionizing the practice of medicine. The ability to create vascular maps with relationships of tumor to vessels has impacted greatly on surgical planning. However, the ability to do surgical planning based on staging patients needs to go far more than where we are today. The ability for the surgeon to interact with the data set and plan the surgery interactively and then make changes on the fly in the operating room is not currently available. Although select sites have used processes to simulate surgery, they are done in a research mode or for select cases and have not really become the standard of care or even available to most patients.

The process of physician interacting with data has changed little with the exception of the willingness to use three-dimensional images. However, most centers review these images on static films and, as we have proven in the past, 3D imaging with real-time rendering is critical. Challenges to provide interactivity to referring physicians wherever they are – be it in surgery, their office, the clinic or home – needs to be met and is a challenge that goes unsolved.

The tools available to the physician have improved greatly over the years with real-time rendering. However, these tools are still, for the most part, rudimentary. Although some companies and research sites have developed new tools, they are not widely available. With the cost of medicine increasing far greater than the GNP, there is hope that computer assisted imaging and analysis of data ,when done correctly, will help lower the cost of medicine and, at the same time, improve patient care. This has always been a challenge and is still an unfulfilled promise.

In this panel, I will present some of the latest images and state-of-the-art studies as seen in our practice today. I will also address what changes are needed to make these images more helpful to the referring physician and how we can better reach the ultimate goal which is to improve care for our patients. The challenges for the next decade will be defined.

6.1 Elliot Fishman Bio

Elliot K. Fishman, MD, FACR, is Professor of Radiology and Oncology at The Johns Hopkins University School of Medicine, and Director of Diagnostic Imaging and Body CT, Russell H. Morgan Department of Radiology and Radiological Science, The Johns Hopkins Hospital, Baltimore, Maryland. Dr. Fishman's research interests include spiral and multidetector CT scanning, CT angiography and computer-based solutions to medical imaging. He has helped develop the field of 3D medical imaging with particular interest in real-time visualization and volume visualization. Dr. Fishman has authored or co-authored more than 700 peer-reviewed scientific papers.